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# EMISSIONS OF FREON TF FROM THE BNPD CENTRAL MAINTENANCE FACILITY LAUNDRY

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The concentration of Freon TF in the exhaust system from the BNPD Central Maintenance Facility laundry has been continuously monitored over an eleven day period from September 12 to 23, 1988. Generally, less than 10 ppm (v/v) was found although a number of peak concentrations above this value occurred each day. The average peak concentration during the sampling period was 37 ppm while the average non-peak concentration was 6.6 ppm, giving an estimated overall average of 17 ppm. The highest concentration observed was 323 ppm during a three hour period of high emissions on September 17, 1988. This apparently was related to a spill of Freon TF in the laundry facility on that date. Other than this occurrence, most other concentrations were below 100 ppm.

## 1.0 INTRODUCTION

Ontario Hydro's Mechanical Design Department is preparing a design proposal and cost estimate for a Freon TF (1,1,2 -trichlorotrifluoroethane, also known as Freon 113) vapour recovery system to be installed in the active exhaust ventilation system at the BNPD Central Maintenance Facility (CMF). Part of the requirements for this design included establishing the concentrations of Freon TF in the exhaust air stream over a period of one to two weeks, on a continuous basis. This report describes the procedures used and



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the results obtained by the Analytical Services Section during a monitoring program carried out in September, 1988 to obtain this information.

## 2.0 METHODOLOGY

### 2.1 Sampling System

A section of the exhaust duct that was accessible from the CMF Mechanical Equipment room was chosen as the sampling location. This site was selected because it was as far downstream as possible from the laundry facility before the exhaust air entered the HEPA/HECA emission control devices, allowing the gases to be well mixed before being sampled.

A 6 mm OD stainless steel probe was positioned in the exhaust duct to allow a sample to be withdrawn from approximately the centre of the duct. A 6 mm OD copper tube was used to transport the sample from the probe to the Freon TF analyzer.

A small diaphragm pump was used to draw the sample gas through the analyzer at a flow rate of 5 L/min. This flow was controlled with a Matheson Model 604 rotameter. The exhaust from the pump was returned to the main exhaust duct via a 10 mm OD polyethylene tube.

### 2.2 Measurement of Freon TF

A Foxboro Analytical Miran 1A General Purpose Gas Analyzer was used to detect the presence of Freon TF in the exhaust air. This is a single beam, variable filter spectrometer capable of scanning the infrared spectral range between 2.5 and 14.5 um. It is also equipped with a variable pathlength gas cell that allows a large range of concentrations of the analyte of interest to be measured.

The analyzer was made specific for Freon TF by choosing a fixed operating wavelength of 8.7 um, the recommended absorbance peak for this species. The pathlength of the gas cell was chosen experimentally so that a 200 ppm (v/v) Freon 113 standard gave an absorbance of about 0.5 on the 0 to 1.0 absorbance range of the instrument.

The optics of the analyzer were protected from particulate material in the sample gas by installing a GF/C glass fibre filter at the sample inlet. The instrument output was fed in parallel to a dual channel chart recorder for the continuous collection of data. The range of one of the recorder's channels was set at 0 to 1 volt to match the full scale output of the instrument, giving a record of all Freon TF concentrations up to

about 400 ppm. The other channel was set at a range of 0 to 0.1 volt to give a more accurate record of the lower concentrations, less than 30 ppm.

Two gas standards with certified Freon 113 concentrations of 25.5 +/- 0.5 ppm and 181 +/- 4 ppm were used to calibrate the Miran 1A analyzer. A cylinder of zero air was initially used for zeroing the instrument during calibration but the same effect was achieved by attaching a series of three absorption tubes to the inlet to the analyzer. These tubes contained silica gel for moisture removal, Ascarite for removing carbon dioxide and finally, activated charcoal for scrubbing out organic vapours, such as any Freon TF, in the room air.

The CMF exhaust air was sampled and analyzed on a continuous basis from 1200 hours on September 12, 1988 to 0900 hours on September 23, 1988, giving close to eleven days of data. Calibrations were performed twice daily, except over the weekend of September 17 and 18, 1988.

## 3.0 RESULTS AND DISCUSSION

### 3.1 Digitization of Data

Except for the time periods during which the instrumentation was being zeroed and calibrated, the monitoring system produced a continuous recording of the absorbance caused by the presence of Freon TF in the CMF exhaust air. These absorbances were directly related to concentrations via calibration curves that were generated daily.

In order to allow the data to be tabulated and evaluated, it was necessary to digitize these absorbances (and consequently, the corresponding Freon TF concentrations) from the recorder output. It was arbitrarily decided to digitize the absorbance reading on the half-hour, regardless of whether it was a peak, a minimum (valley) or some intermediate value. In addition, the time and the absorbance were recorded for every other significant peak that did not fall on the half-hour. This was also done for all minimums that were considered necessary to define the fluctuations in the recorded absorbances. It should be noted that the times were rounded off to the nearest 5 minutes. For example, a peak recorded at 12:28 pm was assigned a time of 12:30 pm.

All of the digitized data are given in the Appendix. Included in this table are indications of whether a time and concentration data pair represent a peak or a minimum (valley) reading. Times at which the instrumentation was being zeroed and calibrated are also shown.

### 3.2 Daily Average Maximum and Non-Peak Emission Concentrations

The data in the Appendix have been used to calculate daily average Freon TF concentrations for all the recorded peaks and for all the non-peak readings. These results are shown in Table I.

**TABLE I**

**Daily Average Maximum and Non-Peak Emission Concentrations**

| | Average Maximum | | Average Non-Peak | |
|---|---|---|---|---|
| Date | Number of peaks | Concentration | Number of readings | Concentration |
| Sept 12 (12 hr) | 12 | 30 ppm | 22 | 5.8 ppm |
| Sept 13 | 25 | 36 ppm | 36 | 4.8 ppm |
| Sept 14 | 18 | 41 ppm | 43 | 4.4 ppm |
| Sept 15 | 30 | 40 ppm | 49 | 8.7 ppm |
| Sept 16 | 20 | 32 ppm | 49 | 8.6 ppm |
| Sept 17 | 30 | 50 ppm | 51 | 9.7 ppm |
| Sept 18 | 17 | 34 ppm | 51 | 6.3 ppm |
| Sept 19 | 23 | 31 ppm | 45 | 4.6 ppm |
| Sept 20 | 24 | 30 ppm | 47 | 5.4 ppm |
| Sept 21 | 25 | 41 ppm | 47 | 6.7 ppm |
| Sept 22 | 26 | 33 ppm | 47 | 5.8 ppm |
| Sept 23 (9 hr) | 9 | 39 ppm | 16 | 5.8 ppm |
| All days | 259 | 37 ppm | 503 | 6.6 ppm |

On average, 24 concentration peaks of greater than 10 ppm occurred each day and 46 non-peak measurements were used to calculate the daily non-peak average concentrations. As seen above, the average maximum concentration throughout the test period was 37 ppm and the average non-peak concentration was 6.6 ppm.

When these results are combined, they give an estimated overall average emission concentration of 17 ppm from the 762 measurements taken over the entire test period. However, this is not a true average because it fails to take into account the actual fractions of the test time that either peak or non-peak concentrations were recorded, a task beyond the scope of the data reduction used in this report. Since low concentrations occurred for the majority of the time, the actual average would be somewhat less than 17 ppm.

## 4.0 CONCLUSIONS

Continuous monitoring of the Freon TF concentration in the exhaust system from the BNPD Central Maintenance Facility laundry over an eleven day period has shown that the emissions vary widely on a daily basis. The following observations can be made from the recorded data:

Generally, a baseline concentration of less than 10 ppm (v/v) with between 17 to 30 concentration peaks of short duration superimposed on it was recorded each day.

These peaks ranged from just above 10 ppm to a high of 323 ppm, averaging 37 ppm over the full eleven days. It would appear that at least the more significant concentration peaks recorded can be correlated with various laundry room operations.

Only four peak concentrations above 100 ppm occurred during the test period; 138 ppm at 13:05 on Sept 14/88, 200 ppm and 323 ppm at 22:40 and 22:50, respectively, on Sept 17/88 and 194 ppm at 08:40 on Sept 23/88.

The average non-peak concentration for the test period was 6.6 ppm. This condition of low emission concentrations was observed during the majority of the test time.

The overall average emission concentration has been estimated to be 17 ppm. This figure has been calculated from 259 recorded peak concentrations and 503 non-peak concentrations. It is likely that

this is an over-estimation of the true average because no time weighting was applied to the data to take into account the fact that the peaks were of short duration and the lower concentrations occurred for the majority of the time.

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## APPENDIX

**Concentrations of Freon TF in CMF Exhaust System.**

Data have been taken from a continuous recording of these concentrations, digitized every half hour or whenever a significant peak or minimum occurred in the recording.

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 12/88 | 1200 | 3.0 |
| | 1210 peak | 46 |
| | 1230 | 5.2 |
| | 1300 | 4.3 |
| | 1330 | 6.3 |
| | 1350 peak | 11 |
| | 1400 peak | 16 |
| | 1430 | 7.0 |
| | 1440 peak | 15 |
| | 1500 | 5.9 |
| | 1520 peak | 10 |
| | 1530 | 5.0 |
| | 1600 | 3.6 |
| | 1630 | 3.5 |
| | 1700 | 7.6 |
| | 1715 peak | 16 |
| | 1730 | 3.3 |
| | 1800 | Zero and calibration |
| | 1830 | 3.9 |
| | 1900 | 3.9 |
| | 1930 | 3.8 |
| | 2000 | 3.9 |
| | 2005 peak | 12 |
| | 2015 peak | 23 |
| | 2030 | 6.6 |
| | 2100 peak | 47 |
| | 2130 peak | 52 |
| | 2200 | 7.4 |
| | 2215 peak | 56 |
| | 2230 | 9.5 |
| | 2250 peak | 50 |
| | 2300 | 12 |
| | 2330 | 7.5 |
| | 2400 | 5.7 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 13/88 | 0030 | 5.1 |
| | 0100 | 4.5 |
| | 0115 peak | 57 |
| | 0130 | 8.8 |
| | 0155 peak | 44 |
| | 0200 | 12 |
| | 0225 peak | 23 |
| | 0230 | 9.1 |
| | 0300 | 3.9 |
| | 0330 | 3.3 |
| | 0400 | 3.0 |
| | 0430 | 2.7 |
| | 0500 | 2.6 |
| | 0530 | 3.5 |
| | 0600 | 5.4 |
| | 0625 peak | 16 |
| | 0630 | 5.1 |
| | 0700 | 3.4 |
| | 0730 | 3.4 |
| | 0800 | 4.5 |
| | 0830 | Zero and calibration |
| | 0900 peak | 10 |
| | 0930 | 1.8 |
| | 1000 peak | 10 |
| | 1030 peak | 74 |
| | 1100 | 2.6 |
| | 1130 | 2.5 |
| | 1200 | 2.0 |
| | 1230 | 1.7 |
| | 1250 peak | 32 |
| | 1255 peak | 35 |
| | 1300 peak | 44 |
| | 1305 peak | 41 |
| | 1330 | 6.7 |
| | 1340 peak | 17 |
| | 1400 peak | 41 |
| | 1430 peak | 48 |
| | 1500 peak | 20 |
| | 1530 valley | 14 |
| | 1600 peak | 50 |
| | 1610 peak | 51 |
| | 1630 | 7.5 |
| | 1635 peak | 39 |
| | 1700 | 6.5 |
| | 1730 | 2.8 |
| | 1800 | Zero and calibration |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 13/88 | 1830 | 1.8 |
| | 1900 | 1.6 |
| | 1930 | 1.5 |
| | 2000 | 9.1 |
| | 2005 peak | 13 |
| | 2010 peak | 14 |
| | 2030 valley | 6.0 |
| | 2100 peak | 42 |
| | 2130 | 3.5 |
| | 2135 peak | 41 |
| | 2200 | 2.9 |
| | 2225 peak | 43 |
| | 2230 | 8.3 |
| | 2300 peak | 45 |
| | 2325 valley | 2.5 |
| | 2330 peak | 44 |
| | 2400 | 2.5 |
| Sept 14/88 | 0030 | 1.7 |
| | 0100 | 9.2 |
| | 0105 peak | 45 |
| | 0130 | 1.0 |
| | 0200 | 1.0 |
| | 0230 | 0.7 |
| | 0300 | 0.7 |
| | 0330 | 1.6 |
| | 0400 | 0.8 |
| | 0430 | 0.9 |
| | 0500 | 1.0 |
| | 0520 peak | 13 |
| | 0530 | 1.7 |
| | 0600 | 1.4 |
| | 0630 | 1.4 |
| | 0700 | 3.1 |
| | 0730 | 1.9 |
| | 0800 | 1.9 |
| | 0830 | Zero and calibration |
| | 0845 | 6.1 |
| | 0900 | 13 |
| | 0905 peak | 32 |
| | 0930 | 5.4 |
| | 1000 peak | 69 |
| | 1030 | 8.9 |
| | 1045 peak | 37 |
| | 1055 peak | 43 |
| | 1100 | 21 |

| Date | | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|---|
| Sept 14/88 | | 1120 peak | 43 |
| | | 1130 | 5.2 |
| | | 1140 peak | 10 |
| | | 1200 | 5.9 |
| | | 1230 | 4.2 |
| | | 1240 peak | 53 |
| | | 1300 | 7.9 |
| | ** | 1305 peak | 138 |
| | | 1315 valley | 4.9 |
| | | 1330 peak | 29 |
| | | 1400 | 5.0 |
| | | 1430 peak | 48 |
| | | 1500 | Zero and calibration |
| | | 1530 | Zero and calibration |
| | | 1600 | 2.0 |
| | | 1630 | 2.1 |
| | | 1700 | 2.0 |
| | | 1730 | 1.8 |
| | | 1800 | 1.6 |
| | | 1830 | 1.4 |
| | | 1900 | 1.8 |
| | | 1930 | 1.4 |
| | | 2000 | 1.7 |
| | | 2030 peak | 20 |
| | | 2100 | 2.8 |
| | | 2110 peak | 31 |
| | | 2130 | 5.8 |
| | | 2145 peak | 33 |
| | | 2200 | 7.5 |
| | | 2230 | 5.7 |
| | | 2235 peak | 12 |
| | | 2245 peak | 47 |
| | | 2300 | 7.6 |
| | | 2325 peak | 30 |
| | | 2330 | 20 |
| | | 2400 | 3.5 |
| Sept 15/88 | | 0030 peak | 41 |
| | | 0055 peak | 53 |
| | | 0100 | 27 |
| | | 0125 valley | 7.7 |
| | | 0130 peak | 36 |
| | | 0135 valley | 11 |
| | | 0145 peak | 39 |
| | | 0200 | 13 |
| | | 0230 | 5.2 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 15/88 | 0300 | 25 |
| | 0303 peak | 60 |
| | 0330 | 8.8 |
| | 0400 | 5.0 |
| | 0415 peak | 39 |
| | 0430 | 13 |
| | 0500 | 3.7 |
| | 0530 | 4.6 |
| | 0600 | 3.8 |
| | 0630 peak | 43 |
| | 0700 | 3.4 |
| | 0715 peak | 43 |
| | 0725 peak | 15 |
| | 0730 | 4.8 |
| | 0800 | 3.2 |
| | 0830 | Zero and calibration |
| | 0900 | 7.5 |
| | 0930 | 4.7 |
| | 0940 peak | 35 |
| | 1000 | 20 |
| | 1005 peak | 46 |
| | 1015 peak | 44 |
| | 1030 | 12 |
| | 1050 peak | 73 |
| | 1100 | 20 |
| | 1115 valley | 8.9 |
| | 1125 peak | 57 |
| | 1130 | 23 |
| | 1135 peak | 45 |
| | 1200 | 5.7 |
| | 1230 | 4.2 |
| | 1255 peak | 50 |
| | 1300 | 22 |
| | 1325 valley | 6.8 |
| | 1330 | 19 |
| | 1335 peak | 45 |
| | 1340 peak | 29 |
| | 1400 | 7.3 |
| | 1425 peak | 30 |
| | 1430 | 19 |
| | 1440 valley | 5.9 |
| | 1455 peak | 19 |
| | 1500 | 9.0 |
| | 1515 peak | 30 |
| | 1530 | 2.2 |
| | 1600 | Zero and calibration |
| | 1630 | 2.8 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 15/88 | 1700 | 2.8 |
| | 1725 peak | 23 |
| | 1730 | 7.2 |
| | 1800 | 2.5 |
| | 1830 | 2.3 |
| | 1900 | 2.4 |
| | 1930 | 2.2 |
| | 2000 | 2.2 |
| | 2030 | 2.2 |
| | 2045 peak | 44 |
| | 2100 | 8.1 |
| | 2130 | 5.6 |
| | 2140 peak | 63 |
| | 2200 | 8.9 |
| | 2230 | 4.7 |
| | 2240 peak | 41 |
| | 2245 peak | 50 |
| | 2300 | 15 |
| | 2315 valley | 6.9 |
| | 2320 peak | 12 |
| | 2325 valley | 4.5 |
| | 2330 peak | 44 |
| | 2335 peak | 41 |
| | 2400 | 8.2 |
| Sept 16/88 | 0030 | 4.5 |
| | 0100 | 5.4 |
| | 0110 peak | 50 |
| | 0130 | 10 |
| | 0135 peak | 12 |
| | 0155 valley | 5.0 |
| | 0200 peak | 34 |
| | 0230 | 3.8 |
| | 0300 | 2.9 |
| | 0330 | 5.0 |
| | 0340 peak | 41 |
| | 0400 peak | 19 |
| | 0430 | 3.5 |
| | 0500 | 24 |
| | 0505 peak | 54 |
| | 0530 | 6.2 |
| | 0545 peak | 29 |
| | 0600 | 8.3 |
| | 0630 | 21 |
| | 0635 peak | 30 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 16/88 | 0640 peak | 30 |
| | 0700 | 5.9 |
| | 0730 | 3.8 |
| | 0800 | 3.8 |
| | 0830 Zero and calibration | |
| | 0900 | 3.6 |
| | 0920 | 55 |
| | 0930 | 23 |
| | 0950 valley | 7.8 |
| | 0955 peak | 41 |
| | 1000 | 14 |
| | 1020 valley | 6.1 |
| | 1025 peak | 27 |
| | 1030 | 21 |
| | 1100 | 6.8 |
| | 1130 | 6.0 |
| | 1200 | 5.4 |
| | 1230 | 5.5 |
| | 1300 | 5.3 |
| | 1320 peak | 35 |
| | 1330 | 15 |
| | 1345 valley | 6.6 |
| | 1400 peak | 12 |
| | 1430 | 6.7 |
| | 1500 | 6.1 |
| | 1530 | 6.1 |
| | 1550 peak | 18 |
| | 1600 | 6.9 |
| | 1630 | 6.5 |
| | 1700 | 5.9 |
| | 1730 | 5.8 |
| | 1800 | 6.2 |
| | 1815 peak | 39 |
| | 1830 | 10 |
| | 1900 | 8.1 |
| | 1930 | 7.4 |
| | 2000 | 7.0 |
| | 2030 | 13 |
| | 2040 peak | 74 |
| | 2100 | 14 |
| | 2130 | 9.6 |
| | 2200 peak | 19 |
| | 2230 | 11 |
| | 2245 peak | 17 |
| | 2300 | 9.4 |
| | 2330 | 7.6 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 16/88 | 2345 peak | 13 |
| | 2400 | 8.4 |
| Sept 17/88 | 0020 peak | 12 |
| | 0030 | 8.3 |
| | 0045 peak | 20 |
| | 0100 | 12 |
| | 0115 peak | 30 |
| | 0130 | 12 |
| | 0150 peak | 33 |
| | 0200 valley | 11 |
| | 0205 peak | 33 |
| | 0225 valley | 12 |
| | 0230 peak | 17 |
| | 0235 valley | 10 |
| | 0245 peak | 51 |
| | 0300 | 17 |
| | 0305 valley | 13 |
| | 0310 peak | 29 |
| | 0315 valley | 15 |
| | 0330 peak | 84 |
| | 0400 | 15 |
| | 0430 | 13 |
| | 0500 | 11 |
| | 0520 peak | 13 |
| | 0530 | 9.5 |
| | 0600 | 8.1 |
| | 0630 | 7.1 |
| | 0700 | 6.5 |
| | 0715 peak | 17 |
| | 0730 | 6.7 |
| | 0800 | 6.4 |
| | 0810 peak | 53 |
| | 0830 | 9.1 |
| | 0835 peak | 18 |
| | 0900 | 7.0 |
| | 0915 peak | 46 |
| | 0930 | 14 |
| | 0945 valley | 8.8 |
| | 0955 peak | 49 |
| | 1000 | 16 |
| | 1020 valley | 7.4 |
| | 1025 peak | 18 |
| | 1030 | 14 |
| | 1100 | 7.9 |
| | 1120 peak | 16 |
| | 1130 | 9.5 |

| Date | | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|---|
| Sept 17/88 | | 1200 | 6.8 |
| | | 1230 | 6.4 |
| | | 1300 | 6.1 |
| | | 1330 | 5.9 |
| | | 1340 peak | 10 |
| | | 1400 | 6.1 |
| | | 1430 | 6.9 |
| | | 1500 | 5.6 |
| | | 1530 | 5.5 |
| | | 1600 | 5.8 |
| | | 1630 | 5.6 |
| | | 1700 | 5.4 |
| | | 1715 peak | 11 |
| | | 1730 | 8.1 |
| | | 1740 peak | 21 |
| | | 1800 | 6.9 |
| | | 1815 peak | 12 |
| | | 1830 | 7.0 |
| | | 1900 | 6.0 |
| | | 1930 | 5.8 |
| | | 2000 | 5.4 |
| | | 2030 | 5.1 |
| | | 2100 | 4.7 |
| | | 2110 peak | 32 |
| | | 2120 valley | 8.3 |
| | | 2130 peak | 68 |
| | | 2135 peak | 63 |
| | | 2140 valley | 29 |
| | | 2150 peak | 77 |
| | | 2200 valley | 6.4 |
| | | 2230 | 9.7 |
| | ** | 2240 peak | 200 |
| | ** | 2250 peak | 323 |
| | | 2300 valley | 57 |
| | | 2330 peak | 73 |
| | | 2355 valley | 8.6 |
| | | 2400 peak | 41 |
| Sept 18/88 | | 0030 | 11 |
| | | 0055 peak | 59 |
| | | 0100 | 23 |
| | | 0120 valley | 10 |
| | | 0125 peak | 21 |
| | | 0130 | 18 |
| | | 0200 | 8.1 |
| | | 0210 peak | 49 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 18/88 | 0230 | 6.3 |
| | 0300 | 4.9 |
| | 0330 | 4.5 |
| | 0400 | 4.3 |
| | 0430 | 4.2 |
| | 0500 | 4.1 |
| | 0530 | 8.3 |
| | 0600 | 6.6 |
| | 0630 | 6.4 |
| | 0700 | 6.0 |
| | 0730 | 5.9 |
| | 0800 | 5.6 |
| | 0815 peak | 26 |
| | 0830 | 3.0 |
| | 0850 peak | 19 |
| | 0900 | 12 |
| | 0920 valley | 5.1 |
| | 0930 peak | 35 |
| | 0940 peak | 47 |
| | 1000 | 8.2 |
| | 1010 valley | 5.0 |
| | 1015 peak | 60 |
| | 1030 | 11 |
| | 1045 valley | 7.1 |
| | 1055 peak | 45 |
| | 1100 | 16 |
| | 1130 | 6.4 |
| | 1200 | 4.4 |
| | 1230 | 4.1 |
| | 1300 | 3.6 |
| | 1325 peak | 18 |
| | 1330 | 10 |
| | 1350 valley | 4.6 |
| | 1400 peak | 15 |
| | 1430 | 5.6 |
| | 1500 | 3.7 |
| | 1510 peak | 17 |
| | 1530 | 5.0 |
| | 1545 peak | 14 |
| | 1600 | 4.4 |
| | 1630 | 3.7 |
| | 1700 | 3.4 |
| | 1710 peak | 19 |
| | 1730 | 5.8 |
| | 1800 | 4.1 |
| | 1830 | 3.6 |
| | 1900 | 3.4 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 18/88 | 1930 | 3.5 |
| | 2000 | 3.3 |
| | 2030 peak | 70 |
| | 2100 | 6.0 |
| | 2120 peak | 29 |
| | 2130 | 6.3 |
| | 2200 | 4.1 |
| | 2230 | 2.8 |
| | 2300 | 2.6 |
| | 2310 peak | 32 |
| | 2330 | 3.7 |
| | 2400 | 4.7 |
| Sept 19/88 | 0030 | 2.8 |
| | 0100 | 2.4 |
| | 0130 | 2.2 |
| | 0200 | 1.8 |
| | 0230 peak | 18 |
| | 0300 | 4.7 |
| | 0330 | 3.1 |
| | 0400 | 2.2 |
| | 0410 peak | 14 |
| | 0420 peak | 30 |
| | 0430 | 7.4 |
| | 0455 peak | 15 |
| | 0500 | 9.6 |
| | 0530 | 1.6 |
| | 0600 | 1.3 |
| | 0630 | 1.2 |
| | 0700 | 0.8 |
| | 0710 peak | 39 |
| | 0730 | 3.2 |
| | 0800 | 1.3 |
| | 0830 | 4.8 |
| | 0900 | 1.8 |
| | 0905 peak | 25 |
| | 0910 peak | 24 |
| | 0930 | 2.5 |
| | 0950 peak | 15 |
| | 0955 peak | 18 |
| | 1000 | 11 |
| | 1005 valley | 6.3 |
| | 1015 peak | 31 |
| | 1030 peak | 21 |
| | 1035 peak | 20 |
| | 1040 valley | 7.5 |
| | 1100 peak | 52 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 19/88 | 1110 peak | 97 |
| | 1130 | 5.9 |
| | 1200 peak | 21 |
| | 1230 | 3.3 |
| | Zero and calibration | |
| | 1300 peak | 15 |
| | 1330 | 4.3 |
| | 1350 peak | 26 |
| | 1400 | 11 |
| | 1430 | 4.7 |
| | 1450 peak | 17 |
| | 1500 | 7.4 |
| | 1530 | 4.0 |
| | 1600 | 3.8 |
| | 1630 | 3.2 |
| | 1700 | 3.2 |
| | 1730 | 3.0 |
| | 1800 | 3.3 |
| | 1830 | 2.8 |
| | 1900 | 2.8 |
| | 1930 | 2.8 |
| | 2000 | 2.7 |
| | 2030 | 2.9 |
| | 2045 peak | 49 |
| | 2100 | 6.8 |
| | 2120 peak | 42 |
| | 2130 | 11 |
| | 2150 peak | 15 |
| | 2200 | 5.5 |
| | 2230 | 4.5 |
| | 2240 peak | 62 |
| | 2300 | 10 |
| | 2320 peak | 38 |
| | 2330 | 9.9 |
| | 2400 | 4.2 |
| Sept 20/88 | 0030 | 3.7 |
| | 0100 peak | 23 |
| | 0110 valley | 7.4 |
| | 0115 peak | 49 |
| | 0130 | 8.4 |
| | 0135 peak | 20 |
| | 0200 | 5.3 |
| | 0230 | 3.4 |
| | 0240 peak | 33 |
| | 0300 | 8.6 |
| | 0320 valley | 3.2 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 20/88 | 0325 peak | 21 |
| | 0330 | 14 |
| | 0400 | 3.6 |
| | 0430 | 1.0 |
| | 0500 | 0.8 |
| | 0530 | 0.5 |
| | 0600 | 0.3 |
| | 0630 | 0.3 |
| | 0700 | 0.6 |
| | 0730 | 0.9 |
| | 0800 | 1.7 |
| | 0825 peak | 19 |
| | 0830 | 9.4 |
| | Zero and calibration | |
| | 0900 | 2.5 |
| | 0920 peak | 41 |
| | 0930 | 9.1 |
| | 0955 peak | 38 |
| | 1000 | 13 |
| | 1030 peak | 32 |
| | 1100 | 4.4 |
| | 1115 peak | 18 |
| | 1120 valley | 6.6 |
| | 1125 peak | 32 |
| | 1130 | 8.0 |
| | 1155 peak | 38 |
| | 1200 | 19 |
| | 1230 | 5.1 |
| | 1300 | 4.9 |
| | 1330 | 4.7 |
| | 1345 peak | 13 |
| | 1400 | 3.4 |
| | 1430 | 3.4 |
| | 1440 peak | 12 |
| | 1450 peak | 10 |
| | 1500 | 4.2 |
| | 1520 peak | 24 |
| | 1530 | 8.9 |
| | 1600 Zero and calibration | |
| | 1630 Zero and calibration | |
| | 1700 | 1.6 |
| | 1720 peak | 32 |
| | 1730 | 17 |
| | 1800 | 3.3 |
| | 1805 peak | 39 |
| | 1830 | 2.1 |
| | 1900 | 1.1 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 20/88 | 1930 | 1.1 |
| | 2000 | 1.0 |
| | 2030 peak | 42 |
| | 2035 valley | 12 |
| | 2040 peak | 25 |
| | 2100 | 6.5 |
| | 2110 peak | 44 |
| | 2130 | 5.7 |
| | 2145 peak | 46 |
| | 2200 | 8.1 |
| | 2230 | 4.4 |
| | 2240 peak | 40 |
| | 2300 | 6.6 |
| | 2330 peak | 47 |
| | 2400 | 6.8 |
| Sept 21/88 | 0030 | 4.5 |
| | 0045 peak | 47 |
| | 0100 | 13 |
| | 0130 | 12 |
| | 0140 peak | 36 |
| | 0200 | 4.4 |
| | 0230 | 3.1 |
| | 0300 peak | 14 |
| | 0330 | 2.7 |
| | 0400 | 3.3 |
| | 0430 | 2.4 |
| | 0500 | 2.3 |
| | 0530 | 2.0 |
| | 0600 | 1.6 |
| | 0630 | 1.6 |
| | 0700 | 1.1 |
| | 0715 peak | 15 |
| | 0730 | 2.0 |
| | 0800 peak | 38 |
| | 0810 peak | 46 |
| | 0815 peak | 23 |
| | 0830 | 9.2 |
| | 0900 | Zero and calibration |
| | 0930 | 3.5 |
| | 0940 peak | 47 |
| | 0955 peak | 52 |
| | 1000 | 5.6 |
| | 1020 peak | 52 |
| | 1030 | 10 |
| | 1035 peak | 50 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 21/88 | 1100 | 2.5 |
| | 1110 peak | 62 |
| | 1130 | 4.0 |
| | 1200 | 2.4 |
| | 1230 | 2.1 |
| | 1235 peak | 36 |
| | 1255 peak | 57 |
| | 1300 | 21 |
| | 1320 valley | 6.2 |
| | 1330 | 16 |
| | 1335 peak | 36 |
| | 1345 valley | 10 |
| | 1350 peak | 41 |
| | 1400 valley | 10 |
| | 1405 peak | 26 |
| | 1430 | 7.0 |
| | 1445 peak | 20 |
| | 1455 peak | 74 |
| | 1500 | 23 |
| | 1530 | 11 |
| | Zero and calibration | |
| | 1600 | 4.7 |
| | 1630 | 4.2 |
| | 1700 | 4.3 |
| | 1730 | 3.6 |
| | 1800 | 3.2 |
| | 1810 peak | 14 |
| | 1830 | 4.0 |
| | 1900 | 4.3 |
| | 1930 | 4.1 |
| | 2000 | 4.3 |
| | 2025 peak | 46 |
| | 2030 | 26 |
| | 2100 | 6.5 |
| | 2130 | 4.4 |
| | 2135 peak | 12 |
| | 2155 peak | 68 |
| | 2200 | 19 |
| | 2220 valley | 7.0 |
| | 2230 peak | 58 |
| | 2300 valley | 5.8 |
| | 2305 peak | 46 |
| | 2330 | 5.5 |
| | 2400 | 3.2 |

| Date | Time (EDT) | | Freon Concentration (ppm) |
|---|---|---|---|
| Sept 22/88 | 0030 | | 2.9 |
| | 0100 | | 2.4 |
| | 0120 | peak | 53 |
| | 0125 | valley | 9.4 |
| | 0130 | peak | 32 |
| | 0200 | | 5.3 |
| | 0215 | peak | 44 |
| | 0230 | | 5.7 |
| | 0300 | | 3.0 |
| | 0325 | peak | 22 |
| | 0330 | | 12 |
| | 0400 | | 0.5 |
| | 0430 | | 0.2 |
| | 0500 | | 1.7 |
| | 0515 | peak | 39 |
| | 0530 | | 5.8 |
| | 0600 | peak | 28 |
| | 0630 | | 2.3 |
| | 0650 | peak | 25 |
| | 0700 | | 9.5 |
| | 0710 | peak | 38 |
| | 0720 | valley | 7.0 |
| | 0725 | peak | 60 |
| | 0730 | | 11 |
| | 0800 | | 3.2 |
| | 0830 | Zero and calibration | |
| | 0900 | Zero and calibration | |
| | 0930 | Zero and calibration | |
| | 1000 | peak | 15 |
| | 1030 | valley | 4.6 |
| | 1035 | peak | 21 |
| | 1040 | peak | 24 |
| | 1100 | | 7.1 |
| | 1130 | | 7.0 |
| | 1200 | | 4.8 |
| | 1230 | | 4.6 |
| | 1245 | peak | 68 |
| | 1300 | | 20 |
| | 1330 | | 6.1 |
| | 1345 | peak | 39 |
| | 1400 | | 7.6 |
| | 1430 | | 4.7 |
| | 1500 | Zero and calibration | |
| | 1530 | | 7.1 |
| | 1600 | peak | 28 |
| | 1620 | valley | 4.8 |
| | 1625 | peak | 30 |

| Date | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|
| Sept 22/88 | 1630 | 6.3 |
| | 1700 | 4.2 |
| | 1730 | 4.3 |
| | 1800 | 5.1 |
| | 1830 | 3.6 |
| | 1900 | 3.4 |
| | 1930 | 3.4 |
| | 2000 | 3.5 |
| | 2010 peak | 18 |
| | 2020 peak | 17 |
| | 2025 peak | 15 |
| | 2030 | 5.2 |
| | 2035 peak | 14 |
| | 2040 valley | 4.1 |
| | 2050 peak | 11 |
| | 2100 | 6.6 |
| | 2110 valley | 4.4 |
| | 2115 peak | 44 |
| | 2130 | 9.6 |
| | 2145 valley | 4.9 |
| | 2150 peak | 44 |
| | 2200 | 9.1 |
| | 2220 valley | 5.1 |
| | 2225 peak | 48 |
| | 2230 | 15 |
| | 2255 valley | 5.5 |
| | 2300 peak | 46 |
| | 2325 valley | 5.7 |
| | 2330 peak | 40 |
| | 2400 | 5.7 |
| Sept 23/88 | 0030 | 5.0 |
| | 0100 | 4.6 |
| | 0110 peak | 32 |
| | 0130 | 5.5 |
| | 0145 peak | 14 |
| | 0200 | 7.1 |
| | 0230 | 5.5 |
| | 0235 peak | 18 |
| | 0250 peak | 14 |
| | 0300 | 7.8 |
| | 0320 peak | 21 |
| | 0330 | 9.2 |
| | 0400 | 5.6 |
| | 0430 | 5.0 |
| | 0500 | 4.8 |
| | 0530 peak | 27 |

| | Date | | Time (EDT) | Freon Concentration (ppm) |
|---|---|---|---|---|
| | Sept 23/88 | | 0540 peak | 16 |
| | | | 0600 | 6.3 |
| | | | 0630 | 5.0 |
| | | | 0700 | 4.7 |
| | | | 0730 | 4.6 |
| | | | 0800 | 4.0 |
| | | | 0830 peak | 17 |
| | | ** | 0840 peak | 194 |
| | | | 0900 | 7.6 |